Dec. 24, 1968 J. M. WARNER 3,417,573

METHOD OF MAKING A SELF-CONTAINED REFRIGERATION SYSTEM

Original Filed Nov. 6, 1963

FIG_3_

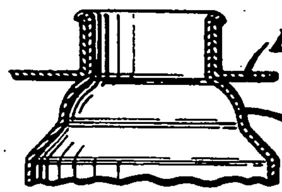


FIG_4_

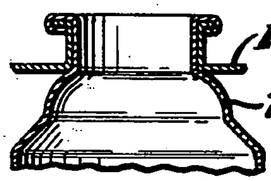


FIG_5_

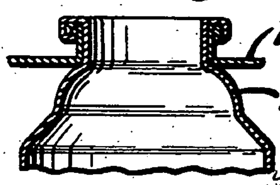


FIG_6_

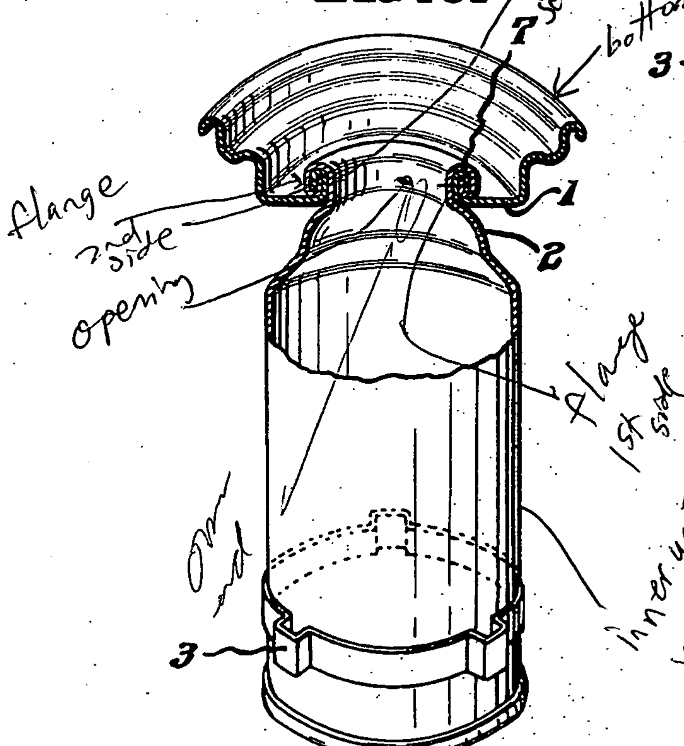


FIG_7_

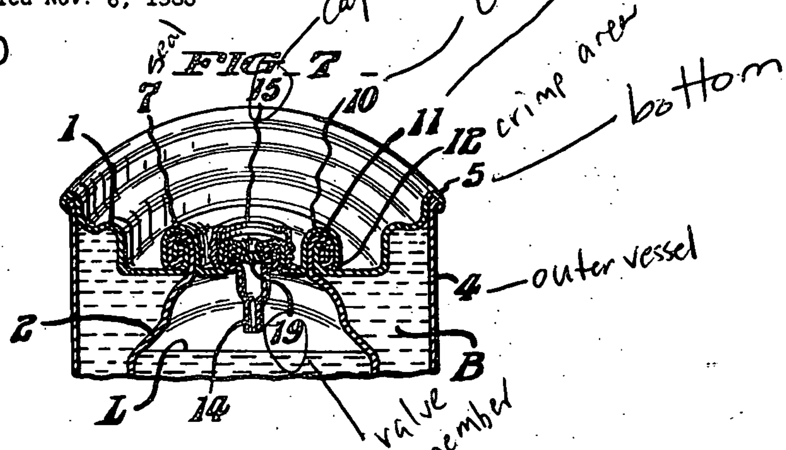


FIG_1_

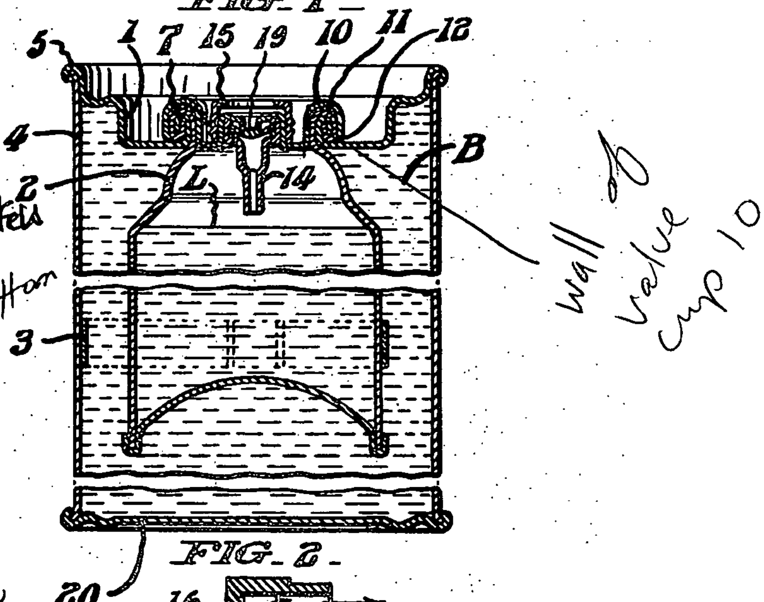
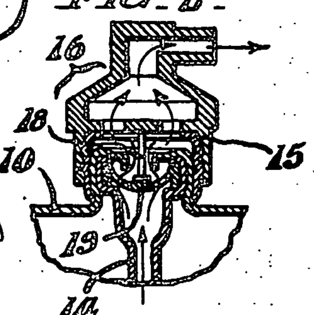


FIG_2_



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United States Patent Office

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METHOD OF MAKING A SELF-CONTAINED REFRIGERATION SYSTEM

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Original application Nov. 6, 1963, Ser. No. 321,792. Divided and this application Aug. 17, 1965, Ser. No. 489,093

2 Claims. (Cl. 62—60)

ABSTRACT OF THE DISCLOSURE

In a method of forming and filling a composite beverage and refrigerant container having a single, rigid, outer container and a single, rigid, inner container disposed within the outer container and affixed thereto along a single common end wall, and having a single valve disposed in engagement with the inner container only for commuicating the inner container with the atmosphere, the steps of first sealing a tubular member at one end, and then placing the open tubular end in overlapping relationship with an upraised lip on the inner annular periphery of an annular member, then rolling the tubular end outwardly to form a sealed connection between the tubular member and the annular member, then placing the tubular member within a second tubular member, then sealing the outer periphery of the annular member to one end of the second tubular member to form an open-ended container, then filling the container so formed with a beverage through the open tubular end, then placing a member across the open tubular end and sealing it to form a sealed beverage container, then charging the inner tubular member with a liquid coolant through the open tubular end thereof, and then placing a valve assembly in said open tubular end so as to seal it.

This is a division of application Ser. No. 321,792, filed Nov. 6, 1963, now abandoned.

This invention relates to self-contained refrigerating systems and more particularly to non-cyclic self-contained refrigerating systems.

There has long been a need for a simple means of cooling the contents of containers, particularly where there is no convenient source of power for operating commercial refrigerating systems or it is burdensome to maintain a cold environment by means of ice chests etc. for objects which are desirable when cold.

Picnickers, golfers, campers, fishermen, hunters and others who enjoy participating in outdoor activities have particular need for a small, portable beverage container having a light weight and automatic means for cooling the beverage itself.

It is therefore an object of this invention to provide a means for efficiently cooling the contents of a beverage container. It is a further object of this invention to provide such cooling with a minimum of inconvenience to the user of the beverage.

The above and further objects of this invention will further become apparent hereinafter and in the drawings, of which:

FIG. 1 is a cross-sectional view of a device embodying this invention, a central portion being broken away.

FIG. 2 is a detailed cross-sectional view of one form of valve which is suitable as a component of the device.

FIGS. 3, 4, 5 and 6 are fragmentary sectional views of successive stages in the formation of the upper portion of a container in accordance with this invention.

FIG. 7 is a fragmentary view in perspective of the completed upper portion referred to above.

Referring now specifically to the embodiment of the invention selected for illustration in the drawings, FIG. 1 shows an outer container 4 having a top 1 and a bottom 20, which contains the beverage B. The number 2 designates an inner container which is a pressure container of stronger construction than the outer container, which is substantially completely full of a liquified coolant under pressure, having a liquid level L. As will be seen, a spacer 3 is provided intermediate the inner and outer containers in order to maintain the lower portion of the inner container 2 in a predetermined fixed position.

The top 1 of the outer container 4 is sealed to the side wall at 5 and is also sealed to the inner container by means of the seal 7 which runs completely around the periphery of the upper portion of the inner container. Located at the center of the top of the inner container is a vent pipe 14 which is swaged into the upwardly flanged inner portion of a closure member 10 which covers the top opening of the inner container and is crimped to the seal 7, as at 12. Suitable gasketing material 11 is interposed between the rolled metal flanges at the seal 7 in order to assure a fluid-tight fit between the inner and the outer containers. The vent pipe 14 is provided at an upper portion thereof with a valve member 19, of the self-closing variety, shown in a depressed position. The valve member 19 is protected from the outside by means of a cap 15 which is crimped onto the central assembly of the closure member 10.

Turning now to FIG. 2 of the drawings, it will be seen that valve means are provided for controllably releasing the fluid under pressure from the inner container 2. This means comprises a valve actuator generally designated 16, screwed onto the cap 15. The valve actuator 16 is provided with a stem 18 which is arranged to contact the valve member 19 in order to open the valve in response to a turning movement of the valve actuator 16. The top 1 is suitably corrugated recessively toward the center and the cap 15 and valve actuator 16 are preferably so proportioned such that the valve actuator 16 is completely recessed below the outward top rim of the outer container 4.

Accordingly, in operation, when the user of the device desires to cool the beverage B, he simply turns the valve actuator 16, thus depressing valve member 19 and controllably releasing gas from the upper portion of the inner container 2. The release of gas allows for vaporization of liquid at the liquid level L, and continuous vaporization of the liquid takes place until the supply of liquid is exhausted or until the valve member 19 is closed. The heat required for this vaporization is absorbed from the remaining liquid and the container 2 which in turn absorbs heat from the beverage B, rapidly cooling it.

It is important in accordance with this invention that the valve member 19 is located above the liquid level L to release the coolant in vapor form rather than in liquid form since the cooling effect in accordance with this invention is dependent upon the absorption of the latent heat of vaporization of the liquid in the inner container 2. In addition to the heat of vaporization, this invention also takes advantage of the heat absorbed due to the expansion of the gas.

It will be appreciated that this invention takes advantage of convection, since as the liquid coolant absorbs heat from the beverage it cools the beverage adjacent the surface of container 2 and the cooled beverage descends along this surface thus setting up convection currents which increase the rate of heat transfer from the beverage to the inner container 2.

It is important in accordance with this invention that the container 2 is substantially surrounded by the container 4, with an intervening layer of beverage to be cooled. The heat of vaporization plus the heat of expansion of the liquid coolant is so great that the temperature at the surface of the container 2 would drop to a value

so low as to give the user frostbite in many cases, if the container **2** were exposed to the touch.

FIGS. 3–7 show a preferred method of assembling the apparatus according to this invention. In FIG. 3, the members **1** and **2** are shown in overlapping relationship, and in FIG. 4 they are rolled down forming an upper, outwardly extending flange. FIG. 5 shows the outwardly extending flange further rolled down, and FIG. 6 shows the entire vertically extending flange turned down upon itself forming the seal **7**. FIG. 7 shows the resulting sealed structure, with the beverage in the outer container and with the liquid coolant in the inner container, and with the valve assembly secured in place and the cap **15** crimped in place.

The method of forming and filling the container in accordance with this invention is of importance. The structure is preferably formed in the sequence illustrated in FIGS. 3, 4, 5, and 6, and the cylindrical portion of the outer container **4**, without any bottom **20**, is sealed to the top **1**, by means of the seal **5**. The outer container **4** is then filled with beverage through the bottom and the bottom **20** is then sealed in place. Then, the liquid coolant is charged into the inner container **2** in a conventional manner and the valve assembly and the cap **15** are crimped in place. The valve actuator **16** is then assembled in a proper position, ready for operation in conjunction with the valve member **19**.

It is an advantage that the inner container is seamed to only one end of the outer container. In this manner, the entire bottom of the inner container is available as a heat transfer surface and this speeds the cooling of the beverage B.

Although any suitable liquified gas refrigerant may be utilized, excellent results have been obtained in accordance with this invention, utilizing the fluorinated hydrocarbon referred to in the trade as "Freon," particularly "Freon 12," which is dichlorodifluoromethane.

It will be appreciated that many variations may be made without departing from the spirit or scope of this invention. For example, although it is desired to provide a valve actuator **16** which may be screwed and unscrewed in order to open and close the valve, and although this is of great advantage in allowing the user to prevent over-cooling of the beverage, in some cases it is possible to utilize a simple "one-shot" valve which simply opens up and emits all of the liquified gas vapors.

It will be appreciated that various changes may be made in the materials used in the containers such as a substitution of glass for metal or plastic or the like. Further, changes in shape may be made, for example, the outer container may be in the shape of a bottle.

Further, variations may be made in the sequence of steps used in the method, for example, inner container **2** may be assembled to top **1** as shown in FIG. 6 with the valve assembly already in place and then charged with liquified refrigerant. This assembly may be charged before or after outer top **1** is sealed to outer can **4**. Also, the liquified refrigerant may be introduced prior to the insertion of the valve assembly. Of course, other variations may be made when desired.

Although this invention has been described with particular reference to a preferred embodiment thereof, it will be appreciated that various modifications may be made without departing from the spirit or scope of the invention. For example, equivalent elements may be substituted for those shown and described, certain parts may be used independently of the use of other parts, and parts may be reversed and assembly and filling sequences may be reversed all without departing from the spirit and scope of the invention as defined in the appended claims.

The following is claimed:

1. In a method of making and filling a self-cooling container having a rigid, tubular, outer container and a rigid, tubular, inner container, each of said containers having one end thereof sealed and the other end thereof connected to an annular member, said annular member being in sealed engagement along its outer periphery with the tubular end of the outer container, and along its inner periphery with the tubular end of the inner container, and having a valve assembly disposed in sealed engagement with said tubular end of the inner container, the steps comprising:

(a) assembling said tubular end of said inner container with the inner periphery of said annular member so as to form a fluid tight seal;
(b) inserting said inner container into said outer container;
(c) sealing the outer periphery of said annular member to said outer container;
(d) filling the outer container with a desired fluid;
(e) sealing the remaining open end of said outer container with an end portion, and, in any sequence, the steps of applying said valve assembly to the inner container opening, and sealing said opening, and filling said inner container with a suitable fluid refrigerant.

2. The method of applying the steps of claim **1** to a composite metallic beverage and refrigerant container whose annular member has an upwardly extending flange along its inner annular periphery, wherein step 1(a) includes the steps of aligning the inner tubular member adjacent to its open end in overlapping relationship with the upwardly extending flange, and then rolling both the tubular member and the upwardly extending flange outwardly and downwardly, to form the sealed connection between the members.

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N. ABRAMS, *Assistant Examiner.*

US006102108A

United States Patent [19]

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[11] Patent Number: 6,102,108

[45] Date of Patent: Aug. 15, 2000

[54] HEAT EXCHANGE UNIT HAVING THERMALLY CONDUCTIVE DISCS HAVING PREFERENTIAL FLOW PATHS

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[73] Assignee: Chill-Can International, Inc., Laguna Niguel, Calif.

[21] Appl. No.: 09/237,873

[22] Filed: Jan. 27, 1999

[51] Int. Cl.[7] F28D 27/02

[52] U.S. Cl. 165/104.12; 165/47; 62/293; 62/294; 62/457.9

[58] Field of Search 165/104.12, 918; 62/457.9, 476, 294, 293

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Primary Examiner—Ira S. Lazarus
Assistant Examiner—Terrell McKinnon
Attorney, Agent, or Firm—Fulbright & Jaworski L.L.P.

[57] ABSTRACT

A heat exchange unit and a beverage or food container including a heat exchange unit therein. The heat exchange unit includes a vessel having a plurality of thermally conductive discs with a layer of compacted adsorbent material such as carbon particles disposed between adjacent discs. The periphery of the discs are in thermally conductive contact with the inner surface of the vessel and each discs has at least one surface which defines a plurality of radially extending grooves terminating at the periphery to define a preferential flow path for gas under pressure to travel along the inner surface of the vessel wall. The periphery of the discs also define a plurality of notches, one at each groove terminal, to enhance the preferential flow path.

12 Claims, 2 Drawing Sheets

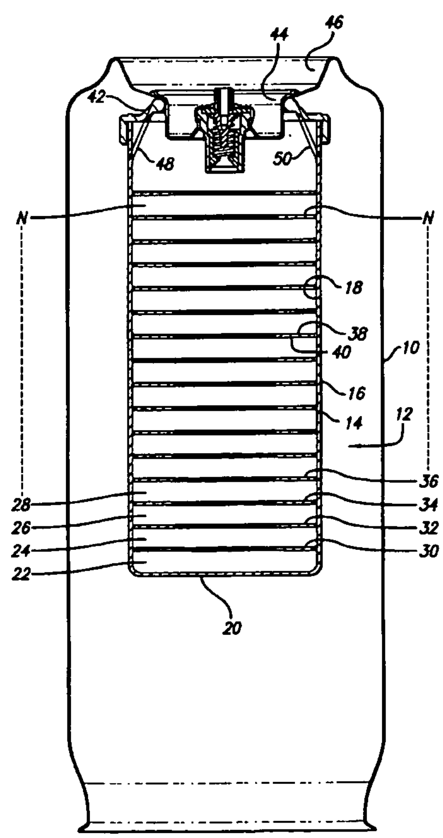

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FIG. 1

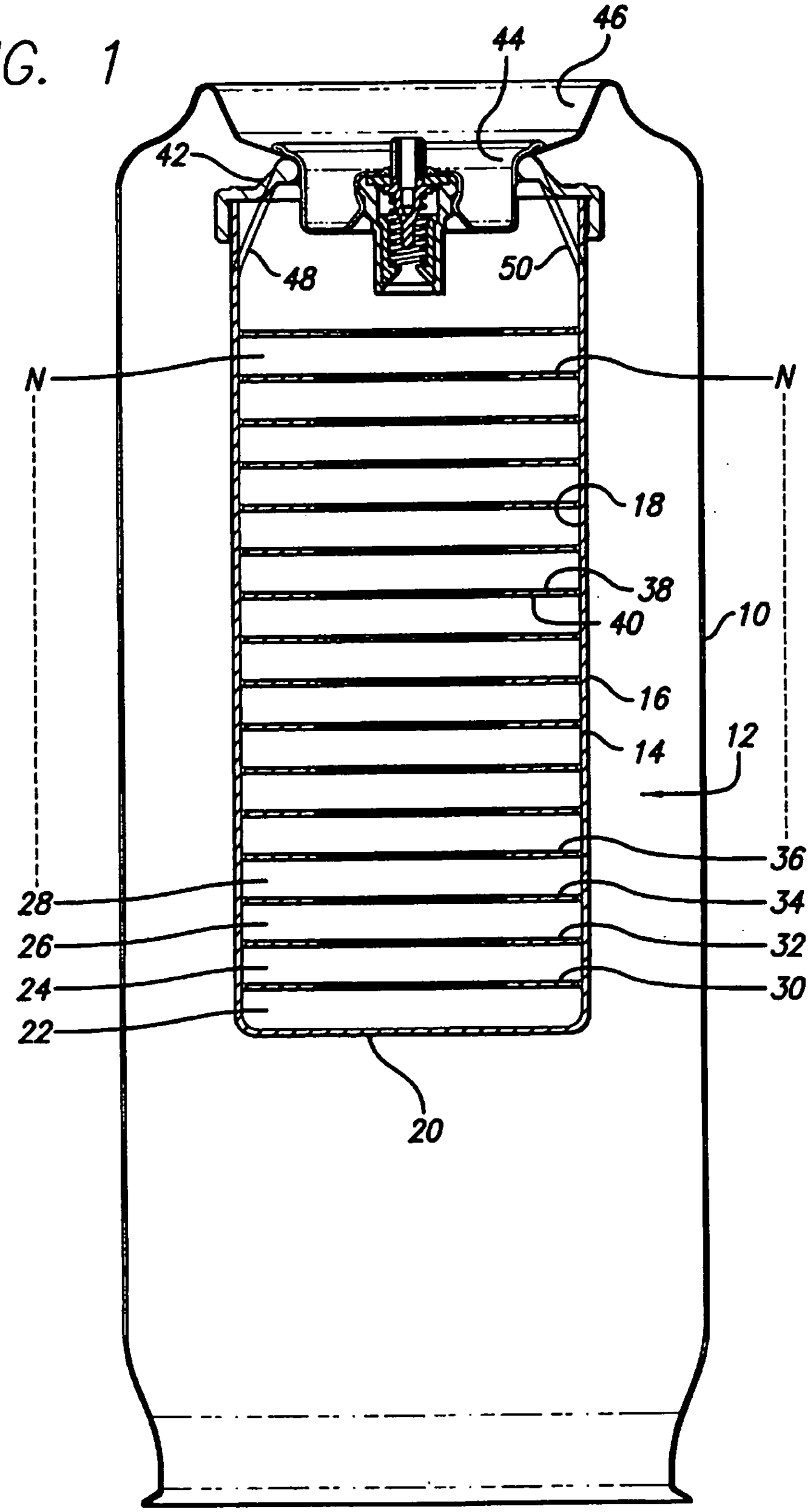


FIG. 2

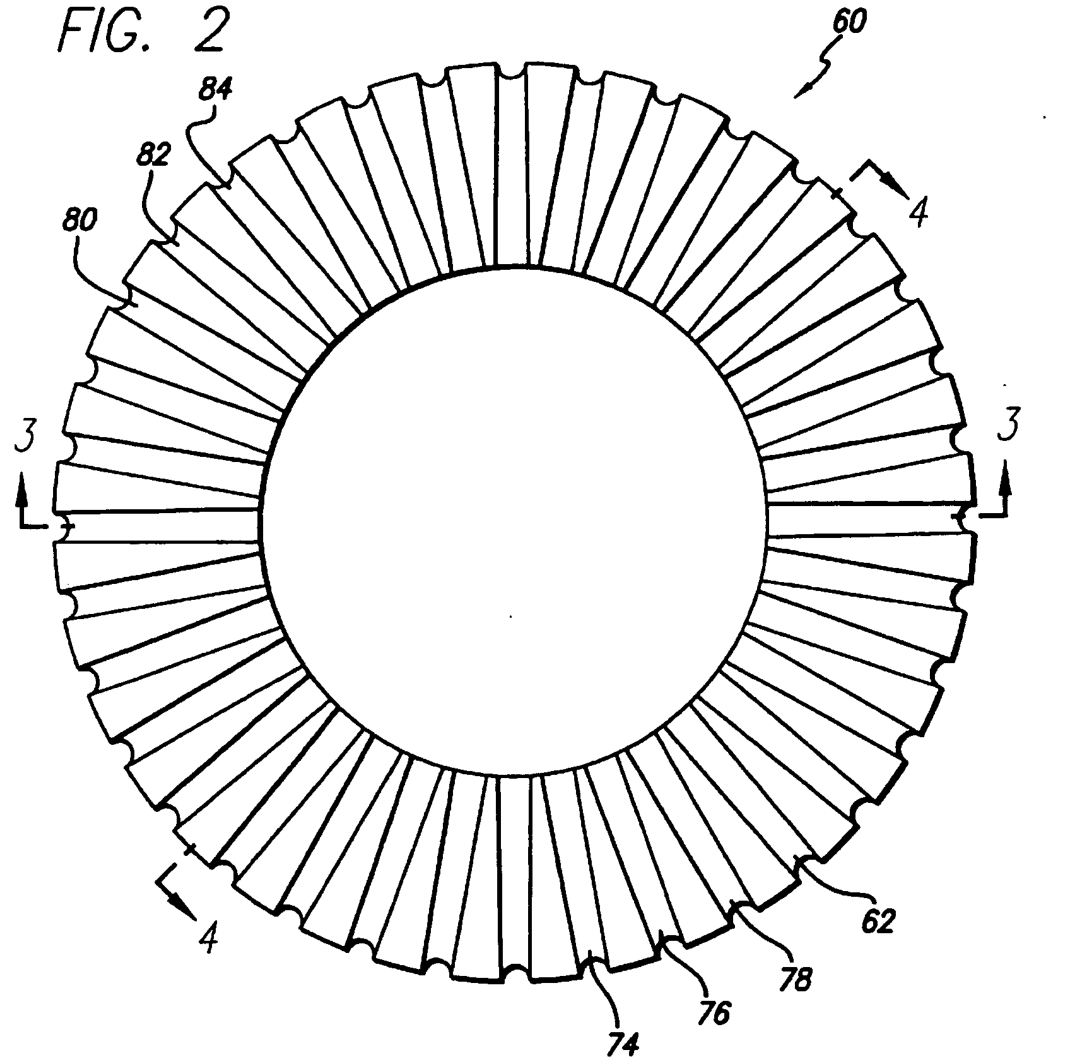


FIG. 3

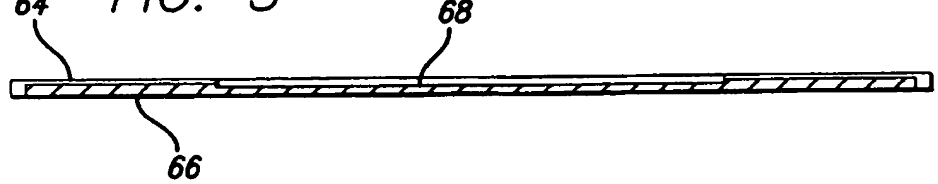
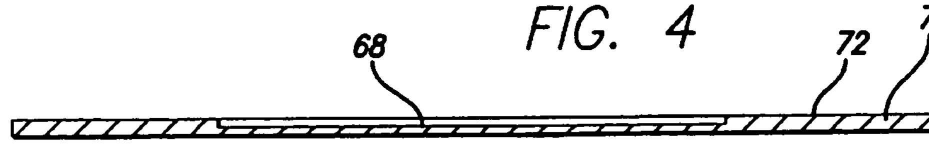


FIG. 4



HEAT EXCHANGE UNIT HAVING THERMALLY CONDUCTIVE DISCS HAVING PREFERENTIAL FLOW PATHS

FIELD OF THE INVENTION

The present invention relates generally to a heat exchange unit for use in containers for self-chilling foods or beverages and more particularly to a heat exchange unit of the type in which temperature reduction is caused by the desorption of a gas from an adsorbent disposed within the heat exchange unit.

DESCRIPTION OF THE ART

Many foods or beverages available in portable containers are preferably consumed when they are chilled. For example, carbonated soft drinks, fruit drinks, beer, puddings, cottage cheese and the like are preferably consumed at temperatures varying between 33° Fahrenheit and 50° Fahrenheit. When the convenience of refrigerators or ice is not available such as when fishing, camping or the like, the task of cooling these foods or beverages prior to consumption is made more difficult and in such circumstances it is highly desirable to have a method for rapidly cooling the content of the containers prior to consumption. Thus a self-cooling container, that is, one not requiring external low temperature conditions is desirable.

The art is replete with container designs which incorporate a coolant capable of cooling the contents without exposure to the external low temperature conditions. The vast majority of these containers incorporate or otherwise utilize refrigerant gases which upon release or activation absorb heat in order to cool the contents of the container. Other techniques have recognized the use of endothermic chemical reactions as a mechanism to absorb heat and thereby cool the contents of the container. Examples of such endothermic chemical reaction devices are those disclosed in U.S. Pat. Nos. 1,897,723, 2,746,265, 2,882,691 and 4,802,343.

Typical of devices which utilize gaseous refrigerants are those disclosed in U.S. Pat. Nos. 2,460,765, 3,373,581, 3,636,726, 3,726,106, 4,584,848, 4,656,838, 4,784,678, 5,214,933, 5,285,812, 5,325,680, 5,331,817, 5,606,866, 5,692,381 and 5,692,391. In many instances the refrigerant gas utilized in a structure such as those shown in the foregoing U.S. Patents do not function to lower the temperature properly or if they do, they contain a refrigerant gaseous material which may contribute to the greenhouse effect and thus is not friendly to the environment.

To solve problems such as those set forth above in the prior art applicant is utilizing as a part of the present invention an adsorbent desorbent system which may comprise adsorbent materials such as zeolites, cation zeolites, silicagel, activated carbons, carbon molecular sieves and the like. Preferably the present invention utilizes activated carbon which functions as an adsorbent for carbon dioxide. A system of this type is disclosed in U.S. Pat. No. 5,692,381 which is incorporated herein by reference.

In these devices the adsorbent material is disposed within a vessel, the outer surface of which is in thermal contact with the food or beverage to be cooled. Typically, the vessel is disposed within and may be connected to an outer container which receives the food or beverage to be cooled in such a manner that it is in thermal contact with the outer surface of the vessel containing the adsorbent material. This vessel of the heat exchange unit is affixed to the outer container typically to the bottom thereof and contains a valve or

similar mechanism which functions to release a quantity of gas, such as carbon dioxide which has been adsorbed by the adsorbent material contained within the inner vessel. When opened the gas such as carbon dioxide is desorbed and the endothermic process of desorption of the gas from the activated carbon adsorbent causes a reduction in the temperature of the food or beverage which is in thermal contact with the outer surface of the inner vessel thereby lowering the temperature of the food or beverage contained therein.

To accomplish this cooling it is imperative that as much carbon dioxide be adsorbed onto the carbon particles contained within the inner vessel and further that the thermal energy contained within the food or beverage be transferred therefrom through the wall of the inner vessel and through the adsorbent material to be carried out of the heat exchange unit along with the desorbed carbon dioxide. It is known in the art that most adsorbents are poor conductors of thermal energy. For example, activated carbon can be described as an amorphic material and consequently has a low thermal conductivity. By compacting the activated carbon to the maximum amount while still permitting maximum adsorption of the carbon dioxide gas thereon does assist some in conduction of thermal energy. However, sufficient thermal energy conduction is not accomplished simply by the compaction of the carbon particles. To allow better heat transfer of the heat contained in the food or beverage it is necessary to incorporate heat transfer means which will assist in conducting heat from the surface of the inner vessel through the carbon particles disposed within the inner vessel to be carried out with the desorbed carbon dioxide gas as it leaves the heat exchange unit.

As above pointed out one of the problems with conventional arrangements utilizing adsorbent desorbent systems is that the flow of desorbed gas does not efficiently remove the heat from the food or beverage in contact with the outer surface of the heat exchange unit. Although part of the desorbed gas leaves the adsorbent adjacent the nearest wall and then travels along the vessel wall to the exit valve, a significant portion also permeates through the adsorbent, and through the exit valve of the vessel without coming into contact with the vessel wall and thus a significant amount of the potential cooling capability of the desorbed gas is effectively wasted. Also, as above pointed out, it is important that the adsorbent, such as the activated carbon particles be compacted as highly as possible without substantially reducing the porosity of the body of absorbent to such a degree that its capability of adsorbing the carbon dioxide gas or the retardation of the rate of desorption from within the body of the absorbent is not deleteriously affected.

SUMMARY OF INVENTION

A heat exchange unit for use in a container for chilling a food or beverage contained therein. The heat exchange unit includes a thermally conductive vessel having a wall. An adsorbent material is received within the vessel for adsorbing a quantity of gas under pressure. A plurality of spaced apart discs having the adsorbent material therebetween and in contact therewith are disposed within the vessel. The discs are constructed of a thermally conductive material and each includes a periphery which is in heat transfer contact with the wall of the vessel. Each of the discs includes first and second outer surfaces with at least one of the outer surfaces defining a plurality of grooves terminating at the periphery of the disc for conducting desorbed gas to the wall of said vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view illustrating a heat exchange unit constructed in accordance with the principles of the present invention assembled with a beverage can;

FIG. 2 is a top plan view of a disc utilized in the heat exchange unit of the present invention;

FIG. 3 is a cross-sectional view of the disc FIG. 2 taken above the lines 3—3 of FIG. 2; and

FIG. 4 is a cross-sectional view of the disc of FIG. 2 above the lines 4—4 of FIG. 2;

DETAILED DESCRIPTION

Although, as above indicated, the present invention is equally applicable to containers housing food or beverage, for purposes of ease of illustration and clarity of description, the following description will be given in conjunction with the illustration of a beverage can having a heat exchange unit constructed in accordance with the principles of the present invention attached to the bottom thereof. This should not be taken as a limitation upon the scope of the present invention. The key factor is that the heat exchange unit of the present invention includes a thin walled vessel which is placed in thermal contact with the food or beverage to be chilled and contains an adsorbent for receiving and adsorbing under pressure a quantity of gas. The desorption of the gas and its passage along the vessel wall causes a reduction in the temperature of the food or beverage which is in contact with the thin walled vessel of the heat exchange unit. The heat from the food or beverage assists in effecting desorption of the gas. The heat exchange unit includes a plurality of heat transfer elements in contact with the wall of the vessel forming the heat exchange unit. Each of the heat transfer elements provides preferential pathways for the desorbed gas to travel from the adsorbent material to the vessel walls so that the gas can travel along the walls of the vessel before leaving the vessel. This enhances the heat transferability of the heat exchange unit and accelerates the chilling process for the food or beverage contained within the container. Preferably each of the heat transfer elements is of the same shape and are arranged so as to be placed in contact with the adsorbent material placed immediately therebelow within the vessel. The heat transfer elements also assist in compacting or compressing the adsorbent material contained within the vessel.

In a preferred embodiment of the heat exchange unit constructed in accordance with the present invention the heat transfer elements are disc shaped with an outer periphery which contacts the inner surface of the wall of the vessel forming the heat exchange unit. In construction of the heat exchange unit a layer of activated carbon particles is introduced into the empty vessel and a heat transfer element disc is placed into the vessel on top of the layer of activated carbon particles then an additional layer of carbon is placed on top of this disc which is then followed by a second disc. This is continued until the vessel is filled with layers of activated carbon particles with a heat transfer element disposed between adjacent layers in such a manner that it is in contact with the top surface of the layer below it and the lower surface of the layer of carbon particles immediately above it. One of the outer surfaces of each of the discs defines a plurality of grooves which terminate at the periphery of the disc. Pressure is applied to the stack of discs and carbon particles by an appropriate fixture to thereby compact the activated carbon particles to a preferred density to maximize the amount of gas under pressure which may be adsorbed by the carbon particles. If desired, pressure may be applied as each of the heat transfer discs is placed within the vessel on top of the underlying layer of carbon particles. The periphery of each of the discs engages the inner surface of the wall of the heat exchange unit in an interference fit and thus by such friction is held in place and assists in maintaining compaction of the carbon particles disposed therebeneath.

Referring now to the drawings there is illustrated a beverage container **10** having disposed therein a heat exchange unit **12** constructed in accordance with the principles of the present invention. The heat exchange unit **12** includes a thin walled vessel **14** which includes an outer surface **16** and an inner surface **18**. Preferably the vessel **14** is cylindrical in configuration and includes a closed bottom **20**. Disposed within the vessel **14** is a plurality of layers of adsorbent material **22, 24, 26, 28** - - - N preferably comprising activated carbon particles. By utilization of the designation N it should be understood that there may be any number of layers of adsorbent material which may be desired depending upon the size of the heat exchange unit **12** and the amount of food or beverage contained within the outer container **10** to be chilled. Also disposed within the vessel **16** is a plurality of heat transfer elements **30, 32, 34, 36** - - - N; also indicating that there may be any number of such heat transfer elements desired again, depending upon the structure of the heat exchange unit **12**. Preferably each of the heat transfer elements is a disc which has an outer periphery which is in thermally conductive contact with the inner surface **18** of the vessel **14**. As will be seen by reference to FIG. **1**, except for the uppermost heat transfer element, each of the elements includes a first surface such as shown at **38** and a second surface such as shown at **40** with the first or upper surface **38** in contact with the layer of adsorbent material disposed above it while the second surface **40** is in contact with the layer of activated carbon adsorbent material disposed below. There is no adsorbent material above the upper surface of the uppermost heat transfer element. As above discussed the construction of the heat exchange unit **12** may be accomplished by placing the layer **22** of adsorbent material in the bottom of the vessel **14** so that it is in contact with the bottom wall **20**. The heat transfer element **30** is then placed in position so that the periphery thereof is in contact with the inner surface **18**. If desired, pressure may be applied to the heat transfer element **30** thereby compacting the layer **22** of adsorbent material to the desired density. The outer periphery of the element **30** contacts the inner surface **18** of the vessel **16** in an interference fit and thereby retains the adsorbent material compacted when pressure is removed therefrom. An additional layer **24** of adsorbent material is then placed within the vessel **14** and a heat transfer element **32** placed thereon and, if desired, compaction pressure applied as above described. This process will be continued until the uppermost heat transfer element N has been positioned and appropriate pressure applied. After the vessel **14** has been appropriately filled with the activated carbon and the heat transfer elements, a cap such as shown at **42** may be placed thereon and an appropriate valve mechanism **44** inserted within an opening provided in the bottom **46** of the beverage can **10** with the combination crimped to hold the valve mechanism **44** and the heat exchange unit **12** in place in the bottom of the beverage can **10**. Alternatively, as shown by the dashed lines **48** and **50**, once the layers of activated carbon and heat transfer elements are disposed within the vessel **16** the upper extension thereof maybe formed inwardly and curled over at its periphery to mate with the valve mechanism. Also, in the event the discs are not structured to attain an interference fit with the wall **18**, such inward forming will retain the compaction of the activated carbon particles disposed between the heat transfer elements. When such is done the vessel **14** is a one piece vessel and the cap **42** may be eliminated with the vessel containing the adsorbent material and the thermally conductive discs secured directly to the bottom of the can by appropriate crimping.

By referring now more particularly to FIGS. **2–4** there is illustrated in greater detail a heat transfer element **60** constructed in accordance with the present invention. The heat transfer element **60** is preferably disc shaped and includes a periphery **62** and a first or upper layer or surface **64** and a second or lower layer or surface **66**. If desired, the central

portion of the disc **60** may define a reduced thickness area or dished out portion **68**. Such a structure provides an annular outer portion **70** to the disc **60**. The upper surface **72** of this annular portion **70** has provided therein a plurality of grooves, three of which are shown at **74**, **76** and **78**. Preferably, these grooves are equi-angularly spaced around the annular portion **70** of the disc **60**. The grooves **74**, **76**, **78** terminate at the periphery **62** of the disc **60** and also communicate with the depressed or dished out portion **68** formed in the disk. If desired, grooves may also be provided on the other surface of the member portion **70** to thereby provide a preferential flow path on each side of each disc. Under such circumstance, the opposite side of disc **60** in FIG. **2**, would be mirror image of the illustration of FIG. **2**.

It should also be noted, particularly in FIG. **2** that the outer periphery **62** of the disc **60** has a plurality of notches **80**, **82** and **84** formed therein. Each of the notches **80**, **82** and **84** are disposed at the outer terminus of one of the grooves which are formed in the upper surface **72** of the annular portion **70** of the disc **60**. The notches **80**, **82** and **84** are thus also equiangularly disposed about the periphery **62** of the disc **60** and extend between the upper and lower surfaces **64** and **66** of the disc **60**.

From the foregoing description it should now be recognized that when the heat transfer elements **30**, **32**, **34**, **36** - - - N are positioned in place with the activated carbon particle layers **22**, **24**, **26**, **28** - - - N disposed and compacted therebetween there is provided a preferential flow path for pressurized gas such as carbon dioxide to enter the heat exchange unit and thereby charge it by adsorbing the gas such as carbon dioxide to the carbon particles. Likewise, upon release through the valve mechanism **44** the pressurized gas upon desorption can leave the heat exchange unit. As the adsorbed gas is permitted to desorb it should be noted that the gas will travel along the preferential flow passageways which are closed by the inner surface **18** of the vessel **16**. The grooves **74**, **76**, **78** which communicate with the notches provide a preferential path for the desorbed gas (or alternatively charging the gas traveling into the carbon particles for adsorption) so that the gas may travel along the notches formed adjacent the inner surface **18** and through the grooves formed on the disc upper surface thereby providing a greater ability for the desorbed gas to leave the interior portion of the compacted carbon particles and to travel outwardly and into contact with the inner surface **18** of the vessel **16**. Through the utilization of a solid metallic disc it should be noted that none of the desorbed gases may travel upwardly and out through the valve mechanism **44** without traveling through the notches **80**, **82**, **84** and along the inner surface **18** of the vessel **14**. Thus, the heat transfer capability of the heat exchange unit is enhanced.

There has thus been disclosed a heat exchange unit for use in containers housing food or beverage for the in site cooling of the food or beverage through the utilization of an adsorption/desorption system. The heat exchange unit includes a plurality of heat transfer elements interposed between layers of adsorbent material such as activated carbon. By activation of a valve a gas under pressure adsorbed onto the carbon particles within the heat exchange unit is caused to desorb and travel through preferential flow paths defined by grooves on the surfaces of the heat exchange elements and then along notches formed in the outer periphery thereof to force the desorbed gas to travel along the inner surface of the wall which defines the heat exchange unit.

What is claimed is:

1. A heat exchange unit for use in a container for chilling a food or beverage contained therein comprising:

(a) a thermally conductive vessel having a wall;

(b) an adsorbent material received within said vessel for adsorbing a quantity of gas under pressure;

(c) a plurality of spaced apart discs formed of thermally conductive material and having a periphery in heat transfer contact with said wall of said vessel, said adsorbent material being disposed between and in contact with said discs, each of said discs having first and second outer surfaces, at least one of said outer surfaces includes a plurality of grooves defining a preferential flow path terminating at said periphery for conducting desorbed gas to said wall.

2. A heat exchange unit as defined in claim **1** which further includes a plurality of notches formed in said periphery of each of said discs.

3. A heat exchange unit as defined in claim **2** wherein each of said notches is disposed on the periphery of said disc at a terminus of a groove.

4. A heat exchange unit as defined in claim **3** wherein at least one of said outer surfaces also defines a centrally disposed recess therein and wherein each of said grooves communicate between said recess and one of said notches.

5. The heat exchange unit as defined in claim **2** wherein each of said discs is constructed of a solid material which extends across the interior of said thermally conductive vessel with the only egress from said vessel for desorbed gases contained therein is along said preferential flow path.

6. The heat exchange unit as defined in claim **5** wherein each of said discs is circular and is formed of a metallic material.

7. A self chilling food or beverage container comprising:

(a) an outer container for containing said food or beverage and a heat exchange unit affixed to said outer container, said heat exchange unit comprising:

1. a thermally conductive vessel having a wall;
2. an adsorbent material received within said vessel for adsorbing a quantity of gas under pressure;
3. a plurality of spaced apart discs formed of thermally conductive material and having a periphery in heat transfer contact with said wall of said vessel, said adsorbent material being disposed between and in contact with said discs, each of said discs having first and second outer surfaces, at least one of said outer surfaces includes a plurality of grooves defining a preferential flow path terminating at said periphery for conducting desorbed gas to said wall.

8. A heat exchange unit as defined in claim **7** which further includes a plurality of notches formed in said periphery of each of said discs.

9. A heat exchange unit as defined in claim **8** wherein each of said notches is disposed on the periphery of said disc at a terminus of a groove.

10. A heat exchange unit as defined in claim **9** wherein at least one of said outer surfaces also defines a centrally disposed recess therein and wherein each of said grooves communicate between said recess and one of said notches.

11. The heat exchange unit as defined in claim **8** wherein each of said discs is constructed of a solid material which extends across the interior of said thermally conductive vessel with the only egress from said vessel for desorbed gases contained therein is along said preferential flow path.

12. The heat exchange unit as defined in claim **11** wherein each of said discs is circular and is formed of a metallic material.

* * * * *

US006125649A

United States Patent [19]

Sillince

[11] **Patent Number: 6,125,649**

[45] **Date of Patent: Oct. 3, 2000**

[54] **HEAT EXCHANGER UNIT WITH CONDUCTIVE DISCS**

[75] Inventor: **Mark Sillince**, Eaton Bray Dunstable, United Kingdom

[73] Assignee: **Chill-Can International, Inc.**, Laguna Niguel, Calif.

[21] Appl. No.: **09/247,877**

[22] Filed: **Feb. 10, 1999**

[51] **Int. Cl.**^{7} **F25B 17/08**

[52] **U.S. Cl.** **62/480**; 62/294; 62/371

[58] **Field of Search** 62/480, 294, 60, 62/371, 293, 5

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Primary Examiner—William Doerrler
Assistant Examiner—Chen-Wen Jiang
Attorney, Agent, or Firm—Fulbright & Jaworski L.L.P.

[57] **ABSTRACT**

A heat exchange unit for use in containers for cooling a food or beverage. The heat exchange unit includes inner end outer vessels with inner vessel having a plurality of thermally conductive discs in thermally conductive contact with an inner surface thereof. An adsorbent material is disposed between adjacent discs is compacted between them to provide maximum adsorbent material per unit volume. The outer surface of the inner vessel defines a plurality of grooves and is in thermally conductive contact with the inner surface of the outer vessel. The grooves provide flow paths for a gas such as carbon dioxide which is adsorbed onto the adsorbent material to flow and exit the heat exchange unit and to carry with it, the heat contained in the food or beverage, thereby lowering its temperatures.

8 Claims, 3 Drawing Sheets

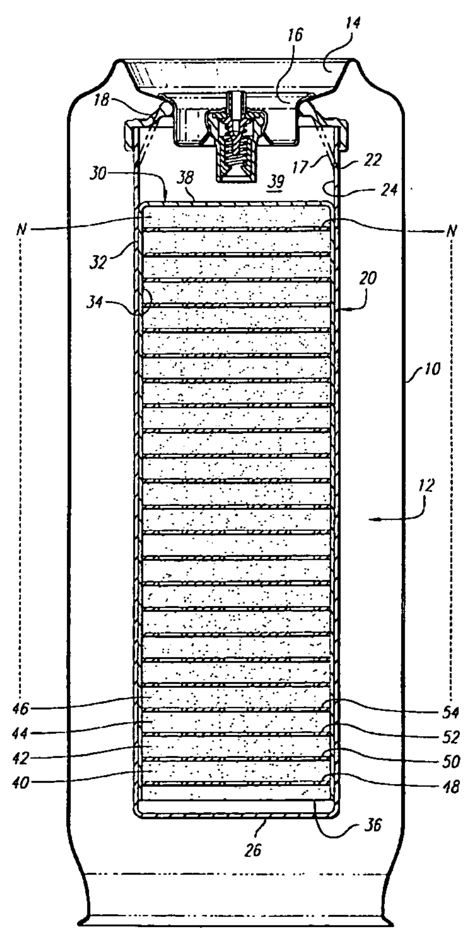
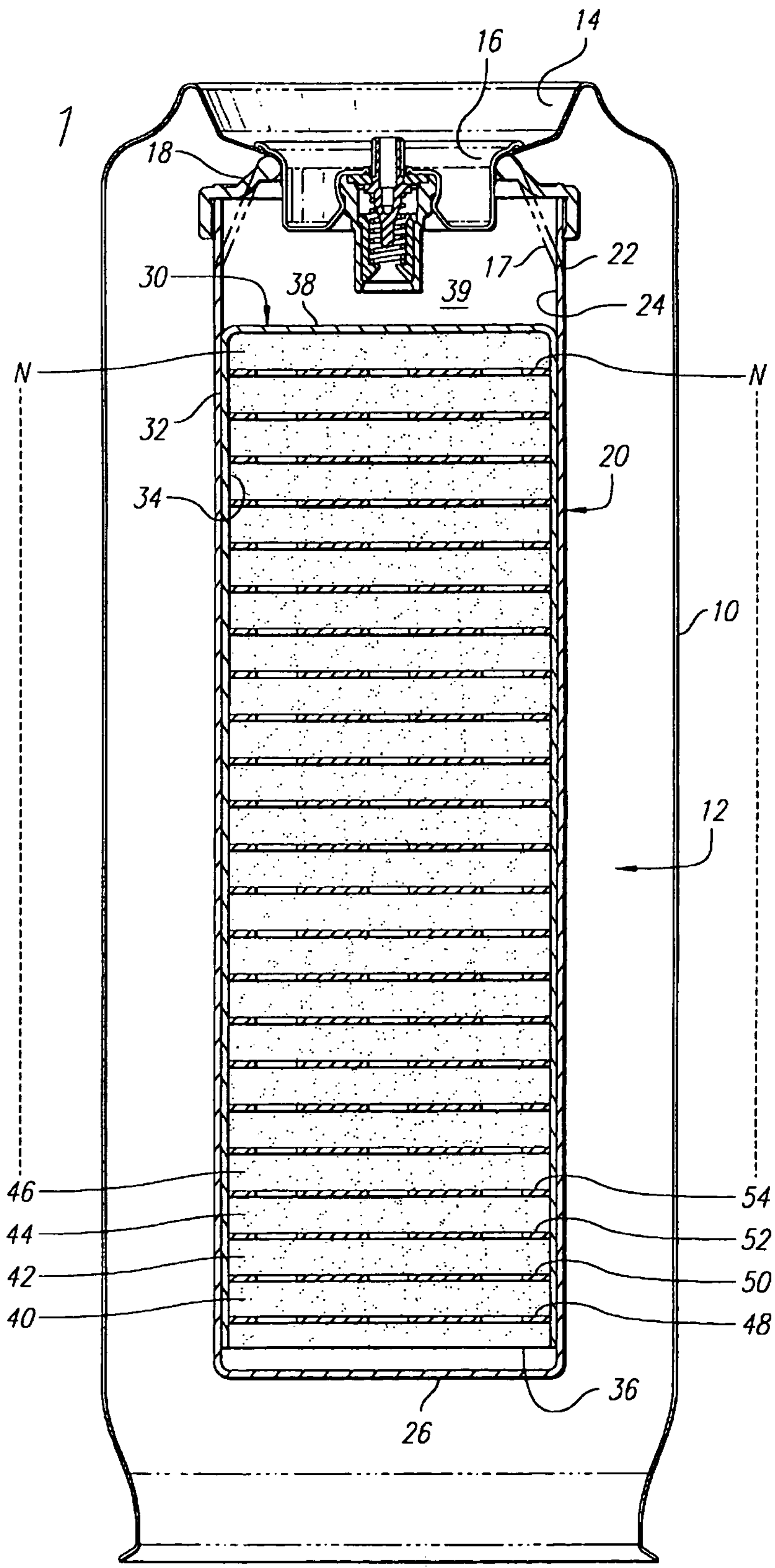


FIG. 1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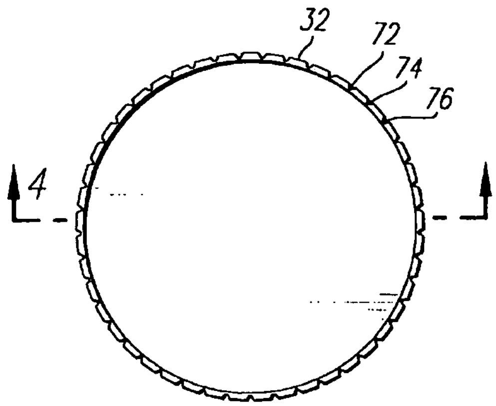
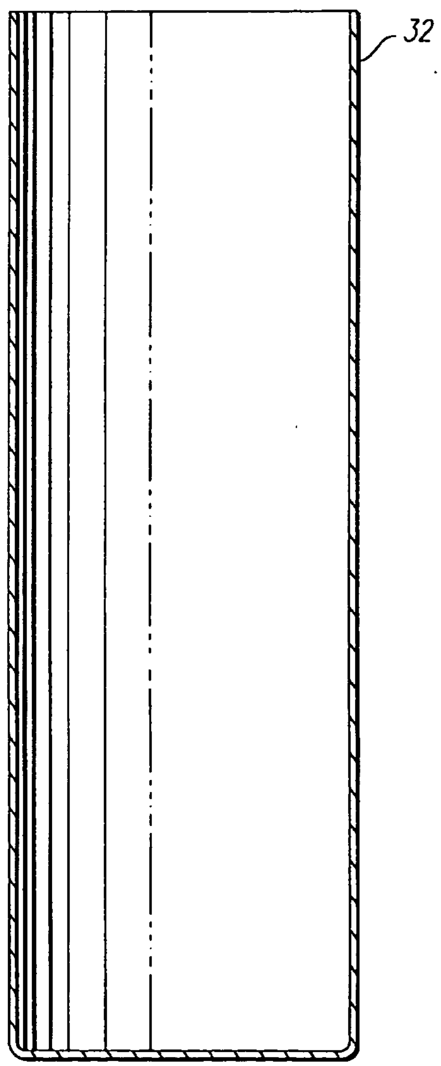


FIG. 3

FIG. 4



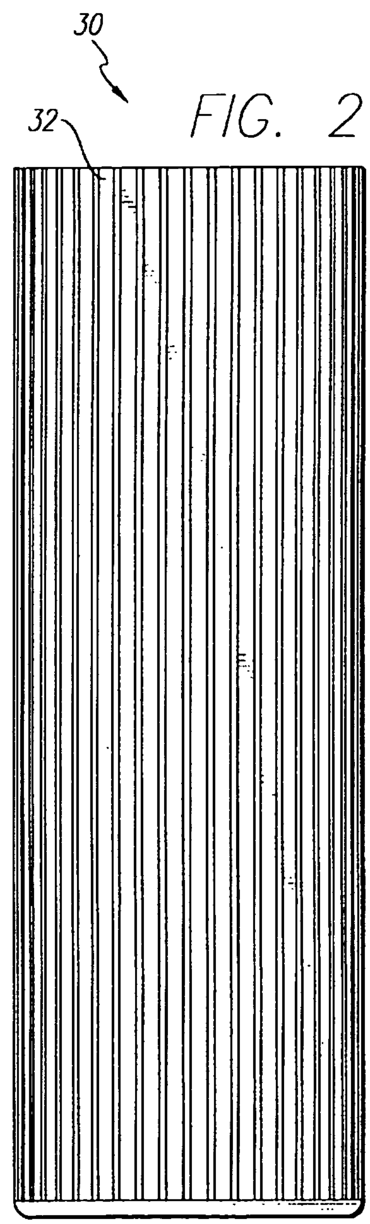


FIG. 2

FIG. 5

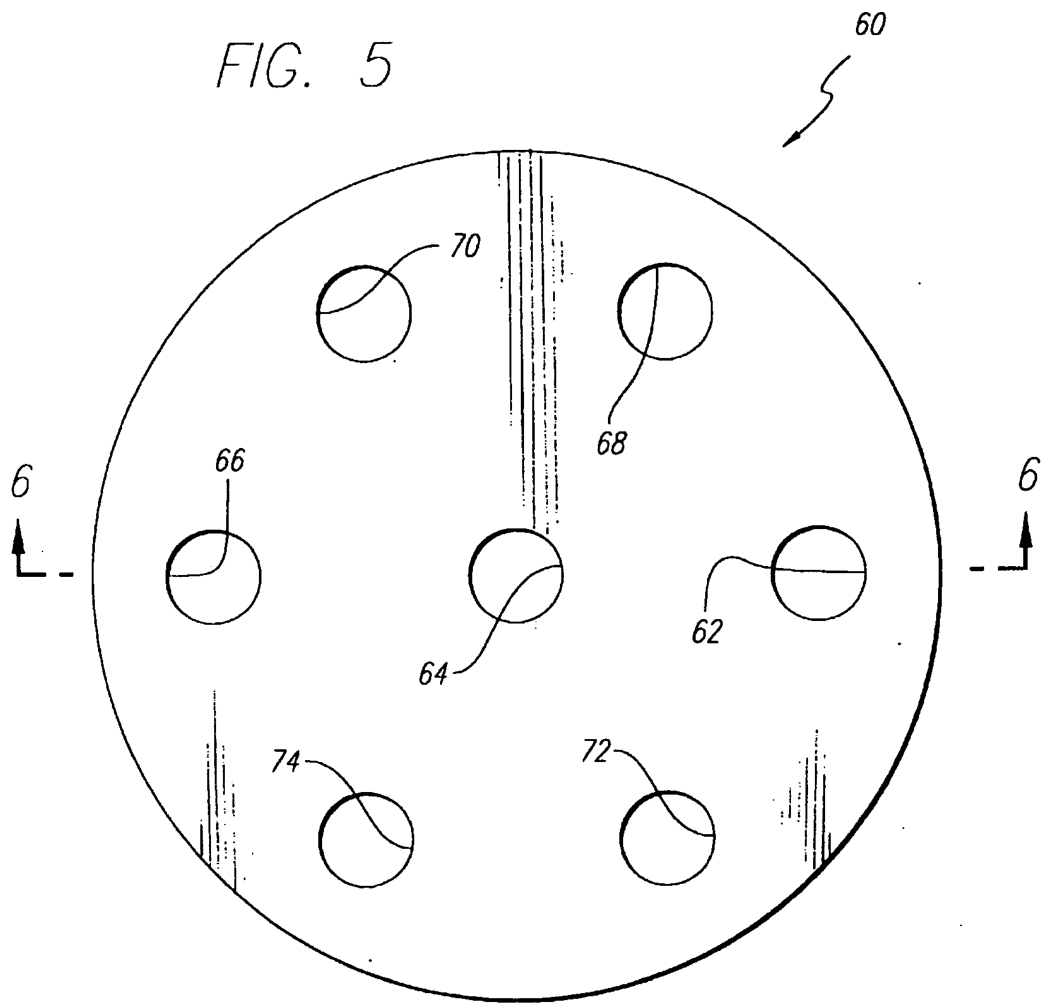
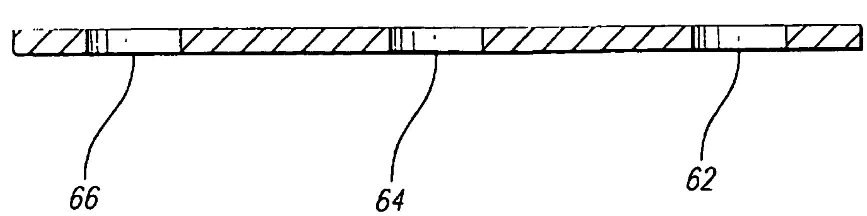


FIG. 6



HEAT EXCHANGER UNIT WITH CONDUCTIVE DISCS

FIELD OF THE INVENTION

The present invention relates generally to a heat exchange unit for use in containers for self-chilling foods or beverages and more particularly to a heat exchange unit of the type in which temperature reduction is caused by the desorption of a gas from an adsorbent disposed within the heat exchange unit.

DESCRIPTION OF THE ART

Many foods or beverages available in portable containers are preferably consumed when they are chilled. For example, carbonated soft drinks, fruit drinks, beer, puddings, cottage cheese and the like are preferably consumed at temperatures varying between 33° Fahrenheit and 50° Fahrenheit. When the convenience of refrigerators or ice is not available such as when fishing, camping or the like, the task of cooling these foods or beverages prior to consumption is made more difficult and in such circumstances it is highly desirable to have a method for rapidly cooling the content of the containers prior to consumption. Thus a self-cooling container, that is, one not requiring external low temperature conditions is desirable.

The art is replete with container designs which incorporate a coolant capable of cooling the contents without exposure to the external low temperature conditions. The vast majority of these containers incorporate or otherwise utilize refrigerant gases which upon release or activation absorb heat in order to cool the contents of the container. Other techniques have recognized the use of endothermic chemical reactions as a mechanism to absorb heat and thereby cool the contents of the container. Examples of such endothermic chemical reaction devices are those disclosed in U.S. Pat. Nos. 1,897,723, 2,746,265, 2,882,691 and 4,802,343.

Typical of devices which utilize gaseous refrigerants are those disclosed in U.S. Pat. Nos. 2,460,765, 3,373,581, 3,636,726, 3,726,106, 4,584,848, 4,656,838, 4,784,678, 5,214,933, 5,285,812, 5,325,680, 5,331,817, 5,606,866, 5,692,381 and 5,692,391. In many instances the refrigerant gas utilized in a structure such as those shown in the foregoing U.S. Patents do not function to lower the temperature properly or if they do, they contain a refrigerant gaseous material which may contribute to the greenhouse effect and thus is not friendly to the environment.

To solve problems such as those set forth above in the prior art, applicant is utilizing as a part of the present invention an adsorbent-desorbent system which may comprise adsorbent materials such as zeolites, cation zeolites, silicagel, activated carbons, carbon molecular sieves and the like. Preferably the present invention utilizes activated carbon which functions as an adsorbent for carbon dioxide. A system of this type is disclosed in U.S. Pat. No. 5,692,381 which is incorporated herein by reference.

In these devices the adsorbent material is disposed within a vessel, the outer surface of which is in contact thermally with the food or beverage to be cooled. Typically, the vessel is connected to an outer container which receives the food or beverage to be cooled in such a manner that it is in thermal contact with the outer surface of the vessel containing the adsorbent material. This vessel or heat exchange unit is affixed to the outer container typically to the bottom thereof and contains a valve or similar mechanism which functions to release a quantity of gas, such as carbon dioxide which

has been adsorbed by the adsorbent material contained within the inner vessel. When opened the gas such as carbon dioxide is desorbed and the endothermic process of desorption of the gas from the activated carbon adsorbent causes a reduction in the temperature of the food or beverage which is in thermal contact with the outer surface of the inner vessel thereby lowering the temperature of the food or beverage contained therein.

To accomplish this cooling it is imperative that as much carbon dioxide be adsorbed onto the carbon particles contained within the inner vessel and further that the thermal energy contained within the food or beverage be transferred therefrom through the wall of the inner vessel and through the adsorbent material to be carried out of the heat exchange unit along with the desorbed carbon dioxide gas. It is known in the art that most adsorbents are poor conductors of thermal energy. For example, activated carbon can be described as an amorphic material and consequently has a low thermal conductivity. By compacting the activated carbon to the maximum amount while still permitting maximum adsorption of the carbon dioxide gas thereon does assist some in conduction of thermal energy. However, sufficient thermal energy conduction is not accomplished simply by the compaction of the carbon particles. To allow better heat transfer of the heat contained in the food or beverage it is necessary to incorporate a thermal conductivity enhancer heat transfer means which will assist in conducting heat from the surface of the inner vessel through the carbon particles disposed within the inner vessel to be carried out with the desorbed carbon dioxide gas as it leaves the heat exchange unit.

As above pointed out one of the problems with conventional arrangements utilizing adsorbent desorbent systems is that the flow of desorbed gas does not efficiently remove the heat from the food or beverage in contact with the outer surface of the heat exchange unit. Although part of the desorbed gas leaves the adsorbent material adjacent the nearest wall and then travels along the vessel wall to the exit valve, a significant portion also permeates through the adsorbent and through the exit valve of the vessel without coming into contact with the vessel wall and thus a significant amount of the potential cooling capability of the desorbed gas is effectively wasted. Also, as above pointed out, it is important that the adsorbent material, such as the activated carbon particles, be compacted as highly as possible without substantially reducing the porosity of the body of adsorbent material to such a degree that its capability of adsorbing the carbon dioxide gas or the retardation of the rate of desorption from within the body of the absorbent is not deleteriously affected.

SUMMARY OF INVENTION

A heat exchange unit for use in a container for chilling a food or beverage contained therein wherein the heat exchange unit includes a thermally conductive outer vessel having a wall with inner and outer surfaces and a closed end. A second vessel having an open end inserted within and in thermal contact with the inner surface of the outer vessel to provide a thermally conductive path therebetween. The outer surface of the inner vessel defining with the inner wall of the outer vessel a plurality of passage ways for conducting gas. Said inner vessel being disposed with its open end adjacent the closed end of said outer vessel. The interior of said inner vessel having disposed therein a plurality of layers of an adsorbent material with thermally conductive discs disposed between adjacent layers of said adsorbent material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional schematic illustration of a beverage can containing a heat exchange unit constructed in

accordance with the principles of the present invention assembled with a beverage can;

FIG. 2 is an elevational view of the inner vessel and the heat exchange unit shown in FIG. 1;

FIG. 3 is a top elevational view thereof;

FIG. 4 is a cross-sectional view thereof taking above the lines 4—4 of FIG. 3;

FIG. 5 is a plan view of a conductive disc disposed within the inter vessel shown in FIGS. 2–4; and

FIG. 6 is a cross-sectional view of the conductive disc taken above the lines 6—6 of FIG. 5.

DETAILED DESCRIPTION

Referring now to the drawings there is shown in FIG. 1 a beverage can **10** having disposed therein a heat exchange unit **12**. The heat exchange unit **12** is affixed to the bottom **14** of the beverage can **10** through the utilization of a valve mechanism **16** which is secured by crimping to an opening in a cap **18** secured to the top of the heat exchange unit and closing the same. As shown by the dashed line **17** the cap **18** may be dispensed with and the heat exchange unit may be formed or necked inwardly as a unitary vessel which is secured to the valve mechanism **16**.

The heat exchange unit **12** includes an outer vessel **20** which includes an outer wall **22** and an inner wall **24** and a closed bottom **26**. Also included as part of the heat exchange unit is an inner vessel **30** having an outer wall **32** and an inner wall **34** and an open end **36**. The end opposite the open end **36** namely end **38** is closed.

Disposed within the interior of the inner vessel **30** is a plurality of layers **40, 42, 44, 46** - - - N of adsorbent material. The use of the designator N indicates that there may be any number of layèrs as may be needed for the application under consideration depending upon the food or beverage to be chilled and the amount of adsorbent to be contained within the heat exchange unit. Also disposed within the interior of the inner vessel **30** are a plurality of thermally conductive discs **48, 50, 52, 54** - - - N again indicating that there may be any number of such thermally conductive discs. As is illustrated, the discs are spaced apart and layers of adsorbent material such as activated carbon **40, 42, 44, 46** - - - N are interposed between adjacent ones of the thermally conductive discs. Each of the thermally conductive discs is in thermally conductive contact with the inner surface **34** of the inner vessel **30** and extends completely thereacross. Preferably the inner and outer vessèls as well as the beverage can **10** are cylindrical in construction and the discs are also cylindrical in construction.

As is more clearly shown in FIGS. **5** and **6** to which reference is hereby made a thermally conductive disc such as shown at **60** includes a plurality of openings as shown at **62** through **74** defined therethrough. Although there are seven such openings shown in the disc **60** there may be any number desired depending upon the particular construction desired. As is illustrated particularly in FIG. **6** the disc **60** is formed of solid material except for the openings **62** through **74** therethrough. The diameter of the disc **60** is such that it is press fitted into the interior of the inner vessel **30** of the heat exchange unit **12** so that the outer periphery **76** accomplishes an interference fit with the inner surface **34** of the inner vessel **30** and is in excellent thermally conductive contact therewith. By the interference fit the disc is also mechanically secured to the inner vessel **30** for reasons to be explained hereinafter.

During construction what typically will occur is that the layers of adsorbent material are placed into the inner vessel **30** with the first being such that it contacts the bottom **38** thereof. After the layer of material is disposed within the inner vessel and against the bottom **38** thereof the top most (as viewed in FIG. **1**) thermally conductive disc such as shown at **60** is inserted in place and press fitted so that there is an intimate thermal contact with the inner surface **34** of the inner vessel **30**. If desired, pressure can be applied to compress the adsorbent particles, such as particles of activated carbon, to the extent desired to enable adsorption of a maximum amount of a gas to be inserted under pressure therein, such for example as carbon dioxide. Additional layers of the activated carbon can then be disposed one after the other with a thermally conductive disc being placed thereon and press fitted into the inner vessel **30** with appropriate compression as above-described until the entire vessel **30** is filled with layers of the activated carbon adsorbent material sandwiched between thermally conductive members such as the discs or the bottom of the inner vessel **30**. As will now be appreciated, by securing the discs **60** mechanically the integrity of the compaction of the carbon particles is maintained.

It should be recognized that it is very important to compact the carbon particles to the maximum extent possible without destroying the ability of the particles to adsorb the carbon dioxide gas. Such compaction is required to obtain the greatest amount of carbon particles within the given space allocated within a particular heat exchange unit. The greater the amount of carbon the larger the amount of carbon dioxide gas can be adsorbed per unit volume which, in turn, increases the cooling effect. That is, more carbon given, more carbon dioxide gas adsorbed, which give more cooling on desorption. Therefore, it is seen that the plurality of thermally conductive discs when inserted, compact the carbon particles and since the discs achieve an interference fit with the interior surface **34** of the container **30**, the compaction of each layer is retained permanently.

As is illustrated in FIGS. **2–4** the inner vessel **30** includes an outer surface **32** which has a diameter which is substantially identical to the inner diameter of the outer vessel **20** so that the inner vessel with its open end **36** facing the closed end **26** of the outer vessel is pressed fitted into the outer container. By such press fitting, the outer surface **32** of the inner vessel **30** is in intimate thermal conductivity with the outer vessel **20**. Along the surface **32** of the inner vessel **30** there are provided a plurality of grooves or slots as shown at **72, 74** and **76** in FIG. **3**. These slots although illustrated as being vertical may be provided in any configuration desired such as helical, in a spiral fashion, tartiutous or the like. The function of the slots is to provide along the inner surface **24** of the outer container **20** a passageway through which gaseous material may pass when the same is flowing in the heat exchange unit. The flowing of such gas, such as carbon dioxide under pressure, will occur during two separate events. The first of these is when the heat exchange unit is charged with the gas such as carbon dioxide to be adsorbed onto the particles of adsorbent material such as the activated carbon particles contained within the interior of the inner vessel **30**. Subsequently, when the valve **16** is activated by depressing the same downwardly the adsorbed gas under pressure is released and upon being desorbed will try to escape through the valve **16** to the atmosphere. By providing the holes in the conductive disc **60** as shown in FIGS. **5** and **6** and the slots or grooves as shown in FIGS. **2** and **3** in the outer surface **32** of the inner vessel **30** the desorbed gas will flow out of the open-end **36** of the inner vessel **30** and through the passageways formed by the slots or grooves, **72, 74, 76** and the inner wall of the outer vessel **20** into the

chamber **39** and then the valve **16**. The openings such as shown as **62, 64** and **66** in the disc **60** will provide pathways for the desorbed gas to flow through the layers of carbon out of the open-end **36** and up through the passage ways along the outer surface of the inner vessel **30**. This will provide a flow path for the desorbed gas to contact the wall of the outer vessel **20** and as the desorbed gas travels through the passage ways to cause the heat contained in the food or beverage which is in contact with the outer surface **22** of the outer vessel **20** to be conducted away from the food or beverage and with the desorbed gas into the atmosphere. This will enhance the cooling effectiveness of the heat exchange unit.

It will also be recognized that the intimate thermal contact between the walls of the inner and outer vessels and the discs causes the heat contained within the food or beverage to also be conducted internally of the heat exchange unit and into contact with the carbon particles. This heat transfer enhances the desorption process therefore releasing more carbon dioxide gas from the carbon particles. As the carbon dioxide gas is desorbed, it passes downwardly (FIG. **1**) through the openings in the discs and out the open end of the inner vessel and upwardly to the chamber **39**. There is thus provided a dual heat flow path thus increasing the effectiveness of the heat exchange unit.

What is claimed is:

1. A heat exchange unit for use in a container for chilling a food or beverage contained therein comprising:

(a) a thermally conductive outer vessel having a wall including a first outer and a first inner surface, said first outer surface adapted to contact said food or beverage, said outer vessel having a first closed end;

(b) an open ended thermally conductive inner vessel having a wall including a second outer surface a second inner surface, and a second closed end, said second outer surface being in thermally conductive contact with said first inner surface;

(c) said second outer surface defining a plurality of grooves extending completely there along;

(d) said inner vessel being received within said outer vessel with the open end thereof facing the closed end of said outer vessel; and

(e) a plurality of layers of adsorbent material in said inner vessel interposed between a plurality of thermally conductive discs each being in thermally conductive contact with said second inner surface, each of said discs defining a flow path therethrough, said adsorbent material extending through said flow paths.

2. A heat exchange unit as defined in claim **1**, which further includes valve means affixed to an end of said outer vessel opposite said first closed end.

3. A heat exchange unit as defined in claim **2**, which further includes a chamber in said outer vessel between said valve means and said second closed end, said chamber being in communication with said grooves.

4. A heat exchange unit as defined in claim **2**, which further includes a refrigerant gas under pressure adsorbed to said adsorbent material.

5. A heat exchange unit as defined in claim **4**, wherein said adsorbent material is carbon and said gas is carbon dioxide.

6. A heat exchange unit as defined in claim **2**, wherein said grooves extend vertically from said open end to said second closed end.

7. A self chilling food or beverage container comprising

an outer container for containing said food or beverage and a heat exchange unit affixed to said outer container, said heat exchange unit comprising:

(a) a thermally conductive outer vessel having a wall including a first outer and a first inner surface, said first outer surface adapted to contact said food or beverage, said outer vessel having a first closed end;

(b) an open ended thermally conductive inner vessel having a wall including a second outer surface a second inner surface, and a second closed end, said second outer surface being in thermally conductive contact with said first inner surface;

(c) said second outer surface defining a plurality of grooves extending completely there along;

(d) said inner vessel being received within said outer vessel with the open end thereof facing the closed end of said outer vessel;

(e) a plurality of layers of adsorbent material in said inner vessel interposed between a plurality of thermally conductive discs each being in thermally conductive contact with said second inner surface, each of said discs defining a plurality of openings therethrough, said adsorbent material extending through said openings;

(f) each of said discs defining an interference fit with said second inner surface and said adsorbent material comprises carbon particles.

8. A heat exchange unit as defined in claim **7** wherein each of said discs compacts the carbon particles adjacent thereto.

* * * * *